NEMA ANSI Power Distribution Product Overview

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Medium Voltage Assemblies

United States Standards

- NEMA – National Electrical Manufactures Association – tells manufactures how to build the equipment standardized for many products. Manufacture sponsored
- ANSI - American National Standards Institute – adopts and makes official the technical documents often created by the IEEE. Government sponsored, work with IEC.
- IEEE – Institute of Electrical & Electronic Engineers – technical experts who create the standards and have compliance & input from all manufactures & engineers.
- NEC (NFPA 70) – National Electrical Code – US based installation standard for minimum electrical design criteria. Not a manufacturing standard. Authority Having Jurisdiction (AHJ) will enforce this standard. AHJ is a local electrical inspector.
- NFPA – National Fire Protection Association – sponsor and edit the NEC. Primarily concerned with preventing fires, etc.
- UL – Underwriter's Laboratories – Third party witnesses for ensuring testing is followed. Can create standards of their own as well.

Metal-Clad switchgear definition

Standard ANSI/IEEE C37.20.2

- All switching and interrupting devices must be draw-out
- When the breaker is in the connected position, no main current carrying parts can be exposed with the opening of a door
- All live parts must be located in grounded metal compartments
- Breaker cells and auxiliary drawers must have automatic shutters
- The main bus and connectors must be fully insulated
- LV items must be insulated from primary voltage by grounded metal barriers

Standard Metal-Clad
5/15kV Switchgear

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Eaton Vac-Clad VCP-W switchgear

Ratings

- Ratings at 5/15kV up to 38kV, 63kA, 4000A
- Utilizes medium-voltage draw-out vacuum circuit breakers, 1200A through 4000A
- Two circuit breakers per structure
- Indoor or Outdoor Options
- Offered as Standard or Arc Resistant Construction (ANSI C37.20.7). Not legally required in the USA.
- Requires rear access for load cable terminations. Top or Bottom exit.
- Ground & Test Devices for Earthing operations
- UL Witnessed

Arc Resistant Metal-Clad
5/15kV Switchgear

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Eaton Vac-Clad VCP-W switchgear

Features & Applications

- Manufactured in Greenwood, SC USA
- Entire fabrication, engineering, testing at one plant. Engineered to Order (ETO).
- Most internal components are manufactured by Eaton at other facilities.
- Applications include Heavy Industry, Oil & Gas, Steel Mills, Hospitals, Universities, Pharmaceuticals, Water & Wastewater plants, etc.
- Eaton enjoys a 50%+ market share in North America for this product line

Draw-Out Metal-Clad
5/15kV Switchgear

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Metal-Enclosed switchgear definition

Standard ANSI C37.20.3

- All switching and interrupting devices typically fixed mounted (non-draw-out) fuses
- Not required to have segregated compartments for line voltage
- No barriers from structure to structure
- No automatic shutters to cover live parts.
- The main bus and connectors do not need to be insulated (often are not)
- LV items must be insulated from primary voltage by grounded metal barriers

Fused Switch for Transformer Primary Disconnect
5/15kV Outdoor Switchgear

Eaton MVS fused switchgear

Ratings

- Ratings at 5/15kV up to 38kV, 61kA Momentary, 600A & 1200A Continuous Current
- Utilizes medium-voltage load-break switch with current-limiting & expulsion fuses
- One switch/fuse per panel
- Requires rear or front access for load cable terminations
- Top, Bottom or side exit of cables
- Can be manually or electrically operated

Metal-Enclosed Switch & Fuse
5/15kV Indoor Switchgear

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Eaton MVS fused switchgear

Features & Applications

- Manufactured in Greenwood, SC USA
- Entire fabrication, engineering, testing at one plant. Engineered to Order (ETO).
- Often applied as a Unit Substation transformer primary disconnect
- Applications include Heavy Industry, Oil & Gas, Steel Mills, Hospitals, Universities, Pharmaceuticals, Water & Wastewater plants, etc.
- Eaton enjoys a 45% market share in North America for this product line

Metal-Enclosed Switch & Fuse
5/15kV Outdoor Switchgear

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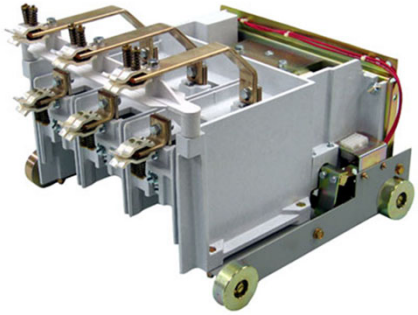
Medium voltage motor control

Standard UL-347

- IEC 60694, 60298 & 60470 compliant
- Very similar to Metal-Enclosed construction
- Arc Resistant offering as well. (ANSI C37.20.7)
- Voltage Range
  - 2300V – 7200V 60kV BIL
  - 11kV & 13.8kV BIL 75kV & 95kV
- Indoor or Outdoor Construction
- Two vacuum starters per structure
- Indoor or Outdoor Options
- Front access for load cable terminations. Top or Bottom cabling exit.



Single structure,
2 High motor starters,
7200V Class E-2 Controller

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Eaton Ampgard motor controller

Ratings

- Up to 3000A main bus Ratings at 7200V
- Utilizes medium-voltage roll-out vacuum contactor, 400A through 800A

- Common Loads (Ratings at 4160V)
  - Motors Induction – 3000HP
  - Motor Synchronous – 3500HP, 1.0 PF
  - Transformers – 2500kVA
  - Capacitors - 2100kVAR
  - LBS Switch
    - Fused or Unfused
    - 600A or 1200A at 6600V

Arc Resistant Ampgard MV Motor Starters

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Eaton Ampgard MV motor controller

Features & Applications

- Manufactured in Asheville, NC USA
- ANSI has its own dedicated equipment for motor starting, not in switchgear.
- Often paired with MV Swgr with a close-coupled connection
- Applications include induction & synchronous motors, transformer & capacitor switching devices.
- Eaton MV VFD's can be supplied in the line-up
- Eaton enjoys a 40-60% market share for this product line

Ampgard MV Motor Controller
7200V

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Power Transformers

Eaton Single Phase Power Transformers

- Overhead (pole-mounted) KVA range: 10 - 167
- Pad-mounted KVA range: 10 - 167
- Primary voltage: Up to 35kV, 150kV BIL
- Secondary voltage: Up to 480V
- Manufactured in Nacogdoches, TX USA

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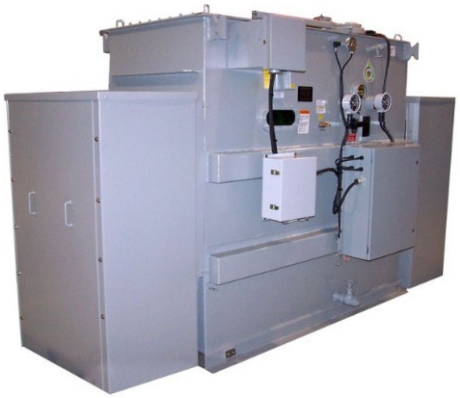
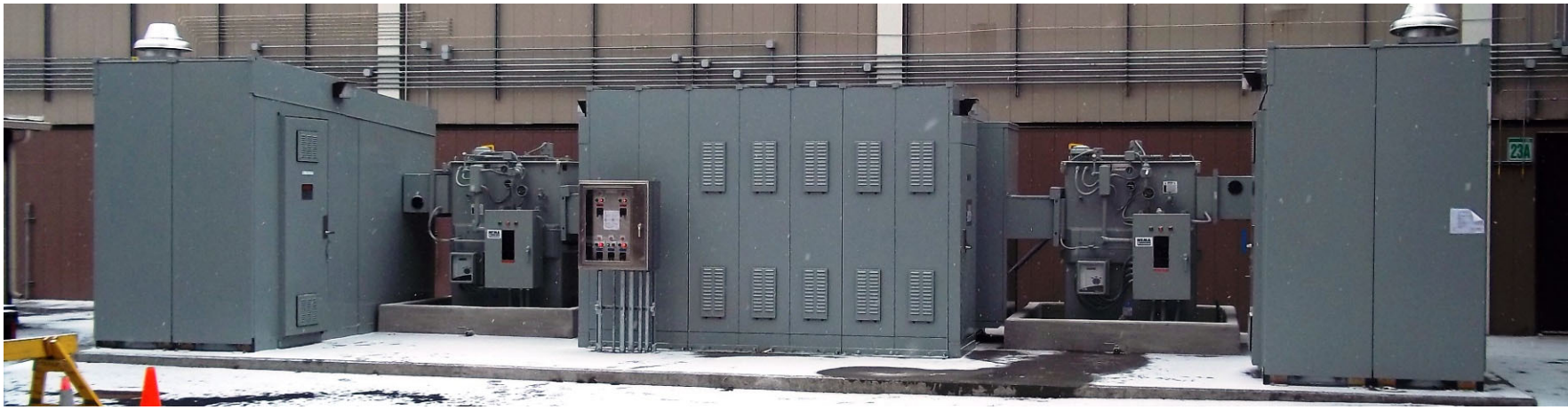
Eaton Three Phase Power Transformers

Pad-Mounted Compartmentalized and Unit-Substation Transformers

- kVA range:
  - 45-12,000
- Primary voltage
  - 2400 to 46,000 volts, Up to 250 kV BIL
- Secondary voltage
  - 120 to 24,940 volts, 125 kV BIL
- Manufactured in Waukesha, WI USA





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Low Voltage Assemblies

LV Metal-Enclosed switchgear definition

Standard ANSI/IEEE C37.20.1 & UL-1558

- Note there is NO Metal-Clad LV Swgr.
- Half-second (0.5s) full selective coordination rated.
- Designed for Air Power Circuit Breaker application with Short-Time ratings, 800A through 6000A
- 3 & 4 Pole Circuit Breakers
- All switching and interrupting devices are draw-out.
- LV devices below 120V are mounted on the cabinet doors.
- Breaker cells optional automatic shutters
- Typically, LV items must be insulated from primary voltage by grounded metal barriers
- Engineered to Order (ETO) product

LV Metal-Enclosed Rear Access 600V Switchgear

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Eaton Magnum DS LV switchgear

Ratings

- Ratings at 600V, up to 6,000A main breaker, 10,000A main bus rating
- 65 up to 200kA Interrupting Ratings
- Up to four (4) circuit breakers per structure
- Indoor or Outdoor Options
- Offered as Standard or Arc Resistant Construction (ANSI C37.20.7)
- Requires front or rear access for load cable terminations. Top or Bottom exit.
- ARMS Switch Technology often applied
- Two-Step Stored Energy breaker closing, as opposed to MCCB
- Microprocessor based overcurrent protection trip units

LV Metal-Enclosed Front Access 600V Switchgear

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Eaton Magnum DS LV switchgear

Features & Applications

- Manufactured in Asheville, NC USA
- Barriers Between Individual Breaker Cells & Between Breakers & Bus
- Draw-out Breaker Design Allows maintenance on the breaker without de-energizing the entire Line-up
- Integrated Automatic Transfer Schemes & High Resistance Grounding Systems
- Important safety items included beyond that of Switchboards.
- Lower maintenance costs due to robust design.
- Applications include Heavy Industry, Data Centers, Oil & Gas, Steel Mills, Hospitals, Pharmaceuticals, Water & Wastewater plants, etc.
- Eaton enjoys a 50%+ market share in North America for this product line

LV Metal-Enclosed Arc Resistant Rear Access Switchgear

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LV Motor Control Centers

DESIGN FEATURES:

- UL-845 Standard, NEMA ICS 18, NEC Article 430-H
- 600V Class Motor Control Center, 3 Cycle Bus Bracing
- Ratings through 600Vac, 100kA, 3200A Main Bus
- Utilizes low-voltage molded case circuit breakers and starters, 15A through 3200A
- Typically, six NEMA Size starters per panel
- NEMA Starters up to Size 7 (600HP at 480V)
- Front access design for operation & cable connection
- Arc Resistant Device Limited Construction Available

Eaton Freedom Low-Voltage MCC

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Eaton Freedom LV MCC

Features & Applications

- Equipment that can be installed in the LV MCC
- Power Circuit Breakers & MCCB
- Power Factor Correction Capacitors
- PLC's, Ethernet Communications
- VFD & Reduced Voltage Solid State Starters
- Harmonic Mitigation Devices
- Transformers & Panelboards
- Metering
- Surge Protective Devices

LV Motor Control Center

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Eaton Freedom LV MCC & Magnum DS Swgr

Features & Application

- NEMA / ANSI Separates Motor Control from Switchgear
- No Motor Starters in Switchgear
- Entirely Different Specifications & Standards
- Can Combine into one Line-up with Use of Transition Sections
  - Close-Coupling

LV Magnum DS Switchgear &
LV Freedom MCC Close-Coupled into Unit Substation

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Integrated Power Assemblies E-Houses

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LV Switchboards

- Very different from LV Switchgear
- UL-891 Standard
- 600V, 3 or 4 Wire
- 5000A bus max
- Typically, a mix of MCCB & power or insulated case breakers
- Free-Standing or Self-Supporting
- Horizontal bus
- Front and rear accessible
- Commercial type applications

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LV Switchboard Applications

- Surge Protection Quite Common in Low Voltage Equipment
- In power distribution system design, Switchboards feed downstream Panelboards.
- Two-Stage or levels for Surge Protection Approach Recommended
  - 250kA at Service Entrance (Switchboard)
  - 120kA at Lower Panels

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Low Voltage Panelboards

- UL-67 & UL-50 Standards
- 600V Rated, 1200A Maximum
- Panelboards hang on the wall (not self supporting)
- Switchboards rest on the floor (self supporting)
- Supply End-Use loads:
  - Receptacles, lights, heaters, small motors, etc.
- Single, Double and 3 Pole Circuit Breakers
  - Single & Three Phase Loads
- Typically, 480Y/277V and 208Y/120VAC

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Eaton PRLX Panelboards

- Two-Pole Breakers do Not Switch the Neutral
  - 277V or 120VAC output voltage
  - In North America we rarely switch the neutral
    - Exceptions being DC Loads and Automatic Transfer Switches (4 Pole)

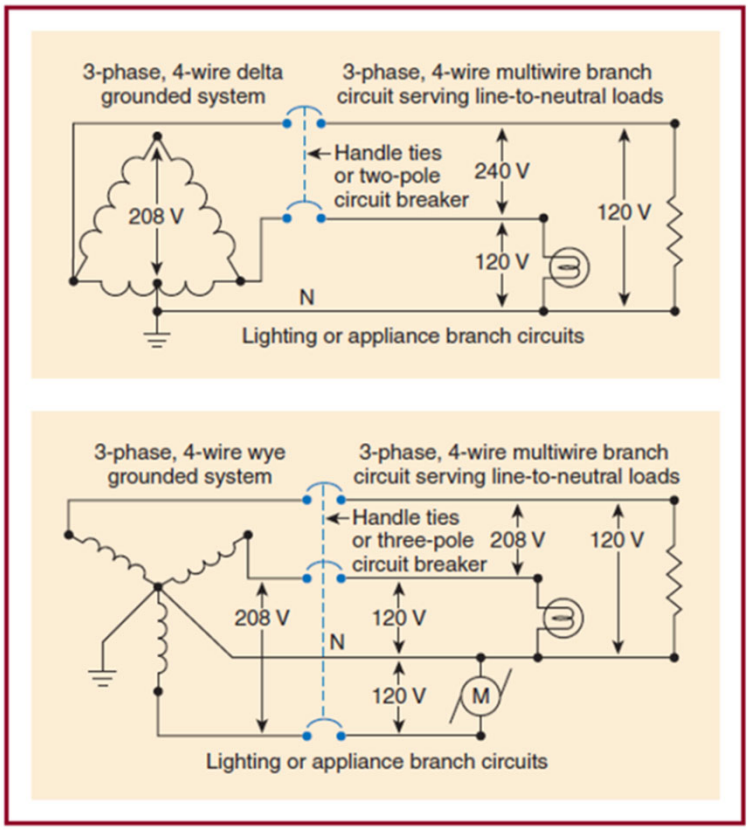

EXHIBIT 240.5 *Examples of circuits in which single-pole circuit breakers are permitted, because they open the ungrounded conductor of the circuit.*

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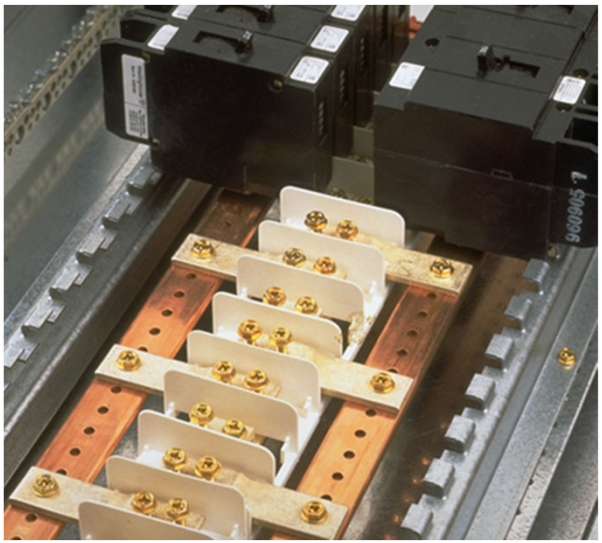
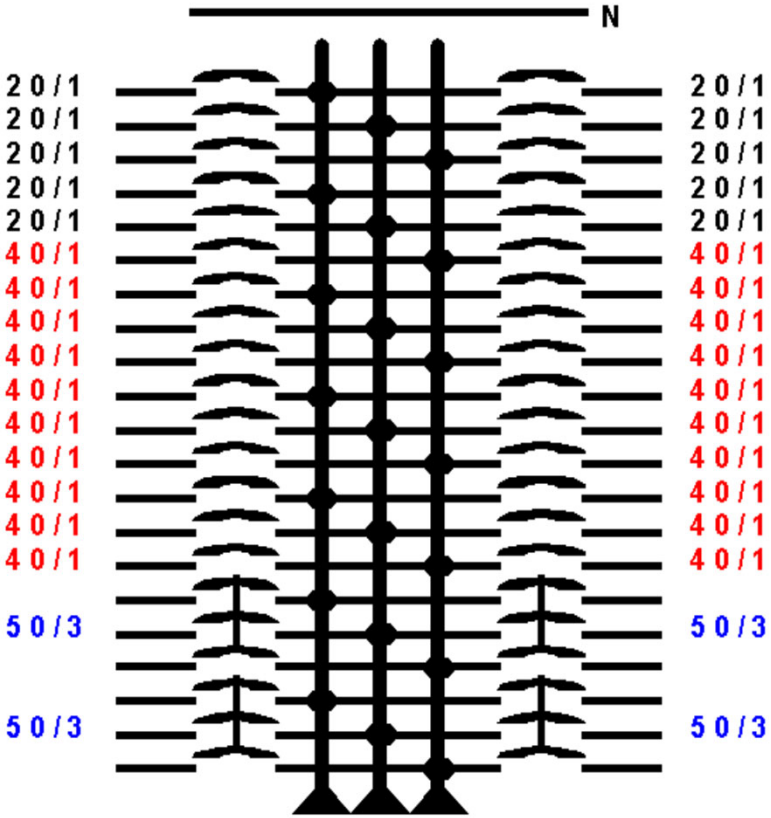
Low Voltage Panelboards

- Panelboard Chassis Circuit Wiring Diagram





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